

Pest Prevention Construction Guidelines and Practices

By Sewell Simmons

“Prevention is the key to effective, least-hazardous pest management programs in schools,” advises Mary-Ann Warmerdam, director of the Department of Pesticide Regulation (DPR).

“If the conditions that attract and support pests—the presence of food, water, shelter, and access—are not eliminated, then other management practices are likely to fail,” said Director Warmerdam. “Everyone involved in the planning, design, construction, remodeling or retrofit of school buildings should be aware of the need for long-term prevention or suppression of pest problems. Pest prevention will reduce overall costs of pest control operations, as well as other maintenance and operating expenses,” she concluded.

A thoroughly integrated approach to pest management in school buildings begins in the early planning stage. Too often, pest management is not considered at this point. The way a building is put together—including materials, construction techniques, and attention to detail—will impact future pest prevention efforts throughout the life of the building. Considering pest management needs during design, development and construction means to incorporate features that will exclude pests, minimize pest habitat, and promote proper sanitation.

Several basic structural features cause most pest problems. Many buildings have pest exclusion problems at doorways and windows. Heating, air conditioning, plumbing, electrical service, and fire sprinklers provide other pest entry points as well. Even in new buildings the electrical conduit, water and

gas lines, and communication cables generally have large openings that permit pest entry. Wall cavities, ceiling cavities, and the space beneath floors can all provide pest shelter. From these areas, pests generally have ready access to the rest of a building. Utilities, overhead suspended ceilings, and air conditioning ducts provide a very effective pest distribution system.

Although pest-resistant building practices most commonly reduce shelter and access, they can also reduce food and moisture sources through proper sanitation, reducing trapped moisture, and improving drainage.

While proper construction practices are the emphasis here, they cannot stand alone. A strong preventive maintenance program is essential. Poor sanitation or leaving entryways open will make even the best-designed and constructed building susceptible to pest problems. Using the practices discussed below, together with routine inspection and awareness of potential pest problems, can greatly reduce or eliminate the potential for infestations especially when followed by responsible maintenance. For more information about pest prevention and maintenance go online to www.schoolipm.info to the “Managing Pests” link, then to the “Pest Prevention and Management” link, then “Pest Prevention—Maintenance Practices and Facility Design.”

The following guidelines and practices illustrate the variety of methods that can be used and their value in pest prevention. Sources listed in the Reference section offer many additional suggestions.

Construction Guidelines and Practices

Foundations and Slabs

Exclusion

- Eliminate gaps or flaws in foundations and slabs, or where the wall framing meets the foundation or slab floor;
- Install physical barriers beneath joints or other discontinuities in the foundation. No hidden cold joint should exist in the foundation unless there is a physical barrier. A sheet metal barrier to termites can be installed from below the wall sill plate or first block course horizontally to embed in a mortar joint;
- Include the design of footings for brick, stone, or other veneers with the other pre-construction foundation planning. A concrete bearing ledge that is poured integrally (monolithic) with the concrete foundation should support these heavy veneers. If poured as part of the foundation, the ledge helps prevent termite entry into the building between the footing and the foundation;
- Use a sand barrier. Use a three-inch layer of sand underneath slab construction. Use one to three-millimeter particle size in place of unsifted sand to provide a permanent termite barrier (western subterranean and Formosan termites);

A thoroughly integrated approach to pest management in school buildings begins in the early planning stage.



- Use naturally durable wood or non-wood materials (more information accessible on these materials at www.mcvicker.com/twd/gwdi97/page000.htm). The only sure prevention of termite problems is the use of building materials other than materials they thrive on and enjoy consuming;
- Eliminate all wood-to-soil contact. Soil should always be from six to 18 inches below any wood member — the greater the distance, the better;
- Extend foundation below ground. Good foundations will normally stop rodents from getting into buildings; however, if foundations do not rest on bedrock, they should extend vertically below ground at least three feet or have an L-shaped curtain wall about two feet deep with a one-foot projection from the building;
- Modify foundations on older buildings with concrete or non-corrosive metal barriers to stop rodents from digging their way in; and
- Check foundation vents to make sure they are tight and appropriately screened (one-quarter inch hardware

cloth to exclude rodents). Be sure to add ventilation, should the material installation reduce air flow by reducing the square inch of vent space to area ventilated equation below building code requirements. A general rule of thumb is 150 square (sq.) inches of vent for every 100 sq. feet of under-building coverage.

Harborage reduction

- Avoid burying or storing cellulose-containing material (wood scraps, form boards, vegetation, stumps, large dead roots, cardboard, trash, and foreign material) near the structure;
- Prior to concrete placement, remove all cellulose-containing material from the area encompassed by the foundation and the area within one foot of its perimeter. The fill material should be free of vegetation and foreign material;
- Prior to concrete placement, clean all cellulose-containing material from cells and cavities in masonry units, and from air gaps between brick, stone, or masonry veneers and the structure; and
- After all foundation work is completed, remove all loose wood and debris

from the crawl space and within one foot of the perimeter of the building.

Moisture management

- Eliminate sources of chronic moisture in and around the structure. This is one of the most important requirements for successfully managing subterranean termites, carpenter ants, and some wood boring beetles. Good drainage design will help to prevent moisture buildup in and around the structure;
- Use moisture barriers. In above-ground foundations, moisture barrier films such as six mil polyethylene can be used to cover the area under the structure. Some builders recommend the use of moisture barriers under slab foundations as well;
- Slope all exterior grades away from the structure to provide drainage;
- Construct and seal all adjoining components such as porches and planter boxes to prevent moisture and soil contact with the structure;
- Design exterior landscaping to avoid moisture build-up around the foundation. Maintain clearance between vegetation and exterior walls;
- Align and/or shield sprinkler irrigation heads to direct spray away from the building; and
- Place foundation wall vents to provide cross ventilation for buildings with crawl spaces. If regrading or remodeling cover vents, additional vents may be needed.

Facilitate inspection and maintenance

- Provide adequate clearance to allow access for inspection and control if needed. Construct decks, fences, patios, planters, or other wooden structural components that directly abut the sidewall of the foundation or structure to provide: (a) an 18-inch clearance beneath or, (b) provide for six-inch clearance between the top of the component and the exterior wall covering or, (c) have components that are easily removable by screws or hinges to allow access for inspection of the foundation sidewall and treatment for termites.

Floors

Exclusion

- Eliminate gaps around floor joists. Floor joists should be built in or fitted onto joist hangers.

Facilitate sanitation/harborage reduction

- Build floors to be durable, non-absorbent, anti-slip, without crevices, and capable of being effectively cleaned. If concrete is used it must be steel-float finished and sealed. Slope floors sufficiently for liquids to drain to trapped gullies or drainpipes. The floor area under food preparation equipment should allow easy cleaning of food spills and remain open to prevent harborage.

may hide. Dead spaces include double walls, false ceilings, enclosed staircases, boxed plumbing, and voids (false bottoms) under cabinets.

Harborage reduction

- Do not use wall coverings that provide insect harborage. Do not install peg-board in kitchens, or other food service areas, animal rooms, or laboratories.

Facilitate sanitation

- Construct walls for easy cleaning. Wall surfaces are best when smooth, impervious, non-flaking and light-colored, and must be capable of being thoroughly cleaned. Do not use absorbent emulsion paints. Stainless steel splash-backs are recommended behind sinks and working surfaces;
- Use durable, non-absorptive shelving material. Keep shelving far enough away from walls to leave room for cleaning; and
- Areas where susceptible items are stored should be well lighted for ease in cleaning and inspection.

Moisture management

- Ventilate cavity walls. Adequate ventilation must be provided but any openings into the roof for this purpose must be screened with mesh or hardware cloth.

Ceilings

Exclusion

- Eliminate gaps around joists. On multi-story buildings, floor joists should be built in or fitted onto joist hangers; and
- Seal all internal partitioning wall and ceiling cavities.

Facilitate sanitation

- Build for ease of maintenance. Suspended ceilings should be made of metal lattice incorporating cleanable panels. Aluminum backed and faced fiberboard has proved successful in many food factories. Flush-fitting ventilation grilles should be installed tightly enough to eliminate openings around the edge of the grille. Solid ceilings should be well insulated to avoid condensation and mold growth, and should be smooth, fire-resistant, light colored, coved at wall joints, and easy to clean.

Facilitate inspection and maintenance

- Build in inspection and maintenance access. Suspended ceilings are helpful in hiding horizontal pipe work and services but access for inspection for pests and maintenance must be built in. Structural walkways should always be provided in large premises.

Utility Entry Points

Exclusion

- Seal utility entry points on the building exterior. Junctures where utilities such as pipes and cables enter structures require special consideration to prevent pest entry;
- Seal entry points within the structure. Once inside the wall, pests may gain entry into the main structure along electrical lines, pipes, poorly sealed fire wall sheathing, or around furnace ducts, hot water heaters, or laundry drains. If pests are able to reach the attic, they may travel from room to room or unit to unit through openings for pipes, ducts, and wiring;
- Pipes, ducts or cables passing through walls should fit tightly or be built into fire stops. Protect joists with metal flanges where pipes or ducts pass through floors and walls. Hot water pipes should be carried in sleeves through vertical or horizontal partitions. Surround the base of elevators, conveyors and machinery with a two-foot high smooth metal fence; conveyor ends should have tight-fitting doors. Seal around all electrical conduits, plumbing, heating pipes, trunking or service ducts that pass through them; and
- Seal duct work. Ensure that all heating and air conditioning ducts are tightly sealed at seams and joints.

Harborage reduction

- Ensure that all pipe insulation has a smooth surface and that there are no gaps between pieces.

Facilitate inspection and maintenance

- When installing pipes, cables and fittings, build in or allow enough wall clearance to enable cleaning around the entry point. Flexible fittings are recommended for gas fittings. All electrical switches should be flush-fitting.

Good foundations will normally stop rodents from getting into buildings.

Moisture management

- In areas where hazard from termite damage is most critical, use floor framing of naturally durable wood and use other applicable methods of termite protection listed above for foundations; and
- Provide adequate ventilation. Allow at least 18 inches of clearance under floor framing and at least 12 inches under floor girders.

Inside Walls, Cabinets, Shelving, Storage Rooms

Exclusion

- Install wall cavity closures and avoid joist/rafter gaps. This will keep out various pests that have gained access to the attic such as birds, mice, rats and squirrels (squirrels are an increasing problem in roof assemblies);
- Eliminate gaps around wall penetrations. Wherever drains, hoists, and vents, conveyors, pipes, cable conduits or ducts pass between buildings through walls or foundations, they should be sealed to prevent the spread of any infestation from one building to another;
- Equip storage areas with self-closing doors to deny pest access;
- Eliminate cracks and crevices (i.e. with sealant, or copper or bronze wool) wherever possible, especially in kitchens and other food preparation and storage areas; and
- Eliminate dead spaces inside storage areas to restrict areas where rodents

Doors

Exclusion

- Ensure that doors are properly installed and correct problems that interfere with a close fit;
- Ensure that roll-up or overhead doors are well fitted. With the door closed, check for gaps along the sides, bottom, and top of the door. A gap at the top is common;
- Use self-closing doors. All doors should close on a level threshold, have smooth, non-absorbent surfaces, be tight fitting and self-closing;
- Select door styles for ease of maintenance and durability. Many food factories use polypropylene or toughened rubber doors for ease of maintenance;
- Correct mail slot/letter plates that are not at least 30 inches above ground level to prevent them from becoming 'rat flaps;'
- Avoid the use of door frames with acute angles;
- Use woodwork that is well-seasoned, properly-knotted, stopped, primed, and given three coats of polyurethane paint;
- Modify conventional doors. External doors should be fitted with metal kick-plates not less than one foot high and the metal plates should also fit jambs and door linings; and
- Use nylon bristle stripdoor sweeps; these are remarkably versatile for pest-resisting conventional doors.

Windows

Exclusion

- Install close-fitting windows and screens. Screens on windows, crawl spaces, and vents are often damaged in school buildings. Check these carefully for needed repair or replacement;
- Slope window ledges. Window ledges or other essential projections should slope at 45 degrees to discourage birds from perching and roosting on them; and
- Modify windows to prevent harborage and access for pests, with no clear passageways to inside. Modify weep holes (openings that allow drainage of moisture) in window frames (e.g., with copper or bronze wool) to prevent access by paper wasps and other insects.

Outside Walls and Building

Perimeters

Exclusion

- Do not install exterior features that attract insects, rodents, birds or other wildlife. Avoid installation (particularly near entrances) of the following:
 - light fixture designs that may provide opportunities for bird perching, roosting or nesting;
 - decorative lattices or other structural features that may inadvertently serve as bird roosts, over entrances to food services facilities; and
 - structural features that provide opportunities for rodent harborage or burrowing. Install bird-proof barriers (e.g., netting) that are designed to prevent both pigeon and sparrow access to preferred nesting sites.
- Use enclosed fire escapes to eliminate bird perching, roosting and nesting, and access for other pests;
- Use durable pest-resistant construction materials. Buildings are constructed from types of materials and design methods that vary greatly in the degree of susceptibility to pest infestation (for example, metal and concrete versus wood). Most structures eventually become less pest-resistant due to deterioration, alteration, or lack of repair. Pre-fabricated building panels usually provide more opportunity for infestation to develop than do solid brick or concrete walls; certain partition or cladding materials such as chipboard, hardboard or blockboard offer little resistance to gnawing rodents and may, especially if damp, encourage molds, booklice and fungus beetles;
- Avoid rough finishes that can be gnawed or provide foothold. Rats and mice will climb up rough exterior surfaces so it is best to eliminate such finishes and to avoid projections or ledges which might give a foothold or provide access to any higher points of entry that are unlikely to be as well proofed as those on the ground floor;
- Screen or otherwise eliminate animal access under decks, porches, and stairways;

- Use gravel to discourage burrowing. Where feasible and inaccessible to students, maintain a two-foot pea gravel strip around buildings to prevent rodent burrowing;
- Install guards on pipes and downspouts. Standard conical or rectangular metal rat guards should be fitted to soil pipes and rainwater downspouts, projecting about nine inches from the pipes and built into the walls at the point where they touch it. Fit tops of open pipes with balloon guards. Mesh fitted over rainwater downspouts will keep out nest debris;
- Design exteriors that have no access to wall cavities. To protect against mice, no external or other cavity wall should have any holes larger than one-quarter inch in diameter;
- Install fitted grills (small mesh) over air intakes; and
- Consider pest management when landscaping near structures.

Exterior Siding

Exclusion

- Avoid gaps at edges and corners.

Facilitate inspection and maintenance

- Allow clearance for inspection between siding and soil surface in order to provide access to inspect for termite infestation, and to prohibit exterior siding contact with soil; clearance between exterior wall coverings (i.e., stucco, siding) and soil on the exterior of a building should not be less than six inches.

Moisture management

- Irrigation/sprinkler systems and risers for spray heads should have sprinkler heads or be located two feet from building so as to prevent water contacting walls; including drought tolerant plants in landscape plans can aid in achieving this goal.

Roof Assembly

Exclusion

- Eliminate rodent access under shingles;
- Build tight roof joints and protect with flashing;
- Fit eave roof tiles with bird stops (that will also exclude bats, bees and wasps); and
- Make sure all attic and soffit vents are properly screened to exclude insects,

birds, and other animals. Use one-quarter inch hardware cloth screen mesh (coordinate with mechanical requirements).

Moisture management

- Direct water from drainage and sprinklers away from walls.

Refuse and Recycling Areas

Exclusion

- Locate site away from building entrances (at least 50 feet from doorways);
- Design site with properly graded concrete or asphalt pads to help prevent rats from establishing burrows beneath them;
- Build to exclude vertebrates. Build refuse sites with a solid enclosure that extends all the way to the ground. Use metal or synthetic materials, as opposed to chain-link or wood, to prevent rodents and other wildlife from gnawing or climbing the enclosure; and
- Close off refuse, recycling, and trash storage areas. Locate storage areas for boxes, paper supplies, and other materials in areas separate from where food

or trash is stored. When stored together, these materials put food and shelter together, favoring pests.

Sanitation

- Place outdoor garbage containers, dumpsters, and compactors on hard, cleanable surfaces; and
- Include a water source at the site for cleaning permanent storage containers and pad surfaces; ensure adequate drainage.

Vertical Shafts

(stairwells, elevator shafts, dumb waiters and refuse chutes)

Exclusion

- Floor cavities should be sealed where they enter shafts or chutes.

Facilitate sanitation/harborage reduction

- Shafts or chutes should be of smooth internal construction. To the extent feasible, build or modify these areas (e.g., use coving at floor to wall junctures, or other means of minimizing corners and sharp angles) to reduce debris accumulation and to facilitate cleaning. ■

Sewell Simmons is an environmental research scientist with Cal/EPA's Department of Pesticide Regulation. For a list of references, please contact the author at ssimmons@cdpr.ca.gov.